Adverse outcomes in older adults attending emergency departments: a systematic review and meta-analysis of the Identification of Seniors At Risk (ISAR) screening tool

ROSE GALVIN1,2†, YANNICK GILLEIT1,3†, EMMA WALLACE1, GRÁINNE COUSINS1,4, MANON BOLMER1,3, TIMOTHY RAINER5,6, SUSAN M. SMITH1, TOM FAHEY1

1HRB Centre for Primary Care Research, Department of General Practice, Royal College of Surgeons in Ireland, Dublin, Republic of Ireland

2 Discipline of Physiotherapy, Department of Clinical Therapies, Faculty of Education and Health Sciences, Health Research Institute, University of Limerick, Limerick, Republic of Ireland

3 Radboud University Nijmegen, Nijmegen, The Netherlands

4 School of Pharmacy, Royal College of Surgeons in Ireland, Dublin, Republic of Ireland

5 Accident and Emergency Medicine Academic Unit, Chinese University of Hong Kong, Prince of Wales Hospital, Sha Tin, Hong Kong

6 Institute of Molecular and Experimental Medicine, Cardiff University, Cardiff, UK

†Both authors contributed equally to the preparation of this manuscript.

Address correspondence to R. Galvin. Tel: +(353) 61 233721; Fax: +(353) 61 234251. Email: rose.galvin@ul.ie

Abstract

Background: older adults are frequent users of emergency services and demonstrate high rates of adverse outcomes following emergency care.

Objective: to perform a systematic review and meta-analysis of the Identification of Seniors At Risk (ISAR) screening tool, to determine its predictive value in identifying adults ≥65 years at risk of functional decline, unplanned emergency department (ED) readmission, emergency hospitalisation or death within 180 days after index ED visit/hospitalisation.

Methods: a systematic literature search was conducted in PubMed, EMBASE, CINAHL, EBSCO and the Cochrane Library to identify validation and impact analysis studies of the ISAR tool. A pre-specified ISAR score of ≥2 (maximum score 6 points) was used to identify patients at high risk of adverse outcomes. A bivariate random effects model generated pooled estimates of sensitivity and specificity. Statistical heterogeneity was explored and methodological quality was assessed using validated criteria.

Results: thirty-two validation studies (n = 12,939) are included. At ≥2, the pooled sensitivity of the ISAR for predicting ED return, emergency hospitalisation and mortality at 6 months is 0.80 (95% confidence interval (CI) 0.70–0.87), 0.82 (95% CI 0.74–0.88) and 0.87 (95% CI 0.75–0.94), respectively, with a pooled specificity of 0.31 (95% CI 0.24–0.38), 0.32 (95% CI 0.24–0.41) and 0.35 (95% CI 0.26–0.44). Similar values are demonstrated at 30 and 90 days. Three heterogeneous impact analysis studies examined the clinical implementation of the ISAR and reported mixed findings across patient and process outcomes.

Conclusion: the ISAR has modest predictive accuracy and may serve as a decision-making adjunct when determining which older adults can be safely discharged.

Keywords: older adults, clinical prediction rule, adverse outcomes, emergency department

179

Background

Older adults are the most frequent users of emergency services, accounting for up to 25% of all emergency department (ED) attendances [1]. Furthermore, older adults utilise more healthcare resources, experience longer ED stays and demonstrate higher rates of adverse outcomes following emergency care such as return to ED, emergency or unplanned hospitalisation and death [2, 3]. Early detection of older adults at risk of these adverse outcomes through systematic screening in the ED setting can serve to identify highrisk groups in need of targeted assessment and early intervention [4, 5], either in the hospital or in the community setting.

A number of tools have been developed to identify older adults at high risk of adverse outcomes following ED visit. These tools serve to quantify the individual contribution that various components of the history, physical examination and basic laboratory results make towards the diagnosis, prognosis or likely response to treatment in a patient [6]. The Identification of Seniors At Risk (ISAR) screening tool was developed to identify adults ≥65 years at risk of future adverse outcomes including functional decline, unplanned hospitalisation or ED visit, nursing home admission or death following an index ED visit or hospital inpatient discharge [7]. The tool consists of a six-item self-report screening questionnaire with dichotomous yes/no responses. A score of ≥2 points indicates that the person is at increased risk of an adverse outcome with reported risk ratios ranging from 2.20 [8] to 3.46 [9]. A summary of the rule is presented in (Supplementary data, available in Age and Ageing online). Since its derivation, a number of studies have attempted to validate the ISAR rule [7–9, 20–48], with varying results. This systematic review and meta-analysis of validation studies of the ISAR serves to summarise the totality of evidence regarding the predictive value in identifying older adults at risk of adverse outcomes after ED discharge/hospitalisation. A secondary aim is to explore impact analysis studies that examine the implementation of the ISAR in clinical practice.

Methods

Study design

This systematic review and meta-analysis was performed according to the principles outlined in the Cochrane Handbook for Systematic Reviews of Diagnostic Test Accuracy [10]. The PRISMA guidelines were also referenced [11]. A detailed protocol is contained on our Departmental website (www.hrbcentreprimarycare.ie/ OurPublications).

Search strategy

A systematic literature search was conducted in September 2015 in PubMed, EMBASE, CINAHL, EBSCO and the

Cochrane Library. We did not seek to identify grey literature as part of this review. A copy of the search string is contained in Appendix 2 (Supplementary data, available in Age and Ageing online). This search was supplemented by hand searching references of retrieved papers and searching Google Scholar.

Study selection and data extraction

Validation studies

Prospective or retrospective cohort study in a hospital setting that attempted to validate the ISAR in older adults following ED discharge/hospitalisation and recorded individual or composite outcomes including functional status/ decline, unplanned return to ED, emergency hospitalisation, nursing home admission or death within 6 months after index visit.

Impact analysis

Randomized (cluster) controlled trials, controlled before– after studies or interrupted time series studies where the ISAR tool was used to screen older adults at high risk of adverse outcomes and a subsequent intervention was compared to usual care in the clinical setting were included. Outcomes included process of care such as number of inpatient bed days, patient outcomes, clinician behaviour and/or cost-effectiveness.

Two reviewers (Y.G., R.G.) independently read the titles and/or abstracts of the identified papers and eliminated irrelevant studies. Studies considered to be eligible for inclusion were read in full and their suitability for inclusion was determined independently by two reviewers (Y.G., R.G.). Disagreements were managed by consensus.

Quality assessment

Quality assessment was independently performed by two reviewers (Y.G., R.G.). Validation studies were assessed using the Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2) tool [12]. Each impact analysis study was assessed using the Cochrane risk of bias tool [13] for randomised controlled trials (RCTs) and Cochrane criteria for controlled before–after studies [14]. Disagreement was managed by a third reviewer (E.W.).

Statistical analysis

Statistical analysis was conducted using Stata version 12 (StataCorp, TX, USA). We constructed 2 × 2 tables (ISAR ≥2) and extracted the number of true positives, false positives, true negatives and false negatives from each study for each outcome at 30, 90 and 180 days. Authors were contacted to provide additional data on study outcomes where necessary. Summary estimates of sensitivity and specificity with 95% confidence intervals (95% CIs) were calculated using the bivariate random effects model. We have employed this methodology in previous studies [15–17]. Sensitivity refers to the proportion of older adults who experience an adverse outcome correctly classified as high risk (ISAR ≥2) whereas specificity refers to those who do not experience an adverse outcome correctly classified as low risk (ISAR <2). In clinical practice, screening tools with high sensitivity are preferable to safely 'rule-out' those at low risk of a subsequent adverse outcome (as opposed to diagnostic tools that generally demonstrate high specificity).

Individual and summary estimates of sensitivity and specificity were plotted on a receiver-operating characteristic (ROC) graph. Statistical heterogeneity was explored using the variance of logit-transformed sensitivity and specificity, with smaller values suggesting less heterogeneity between studies. Bayes' theorem was applied to estimate the post-test probability of an adverse outcome [18]. The c statistic, or area under the curve, with 95% CI describes model discrimination. Values between 0.7 and 0.9 represent moderate accuracy and values greater than 0.9 represent high accuracy [19]. We performed sensitivity analyses to examine the impact of methodological quality on the predictive value of the ISAR.

Results

Study identification

A flow diagram of the search strategy is presented in Figure 1. A total of 32 studies attempted to validate the ISAR and comprised 25 unique patient cohorts [7–9, 20–48]. The remaining seven articles reported on different outcomes using data from existing databases [22, 23, 25, 29,30 36, 43]. Three original studies that conducted impact analyses of the ISAR tool were also identified and are reported separately [49–51].

Study characteristics and quality

Figure 1. Flow of studies in the review.

Appendix 3 (Supplementary data, available in Age and Ageing online) summarises the characteristics of the 32 studies conducted across Europe, North America, Central

America and Asia. Studies ranged in sample size from 83 [30] to 2,057 participants [34]. Twelve studies included a combination of patients who were both discharged and hospitalised after the index ED visit [7–9, 22, 25 ,27, 29, 33, 34, 40, 41, 48], 11 studies only included patients that were discharged following ED visit [20, 21, 23, 26, 28, 30– 32, 39, 42, 46] and 9 included only hospitalised patients [24, 35–38, 43–45, 47]. The duration of follow-up varied from 14 days [30, 31, 35, 36] to 12 months [32, 47], with outcomes at 30 and 90 days the most commonly reported follow-up periods. Additional unpublished data were provided by ten authors [8, 26, 28, 37, 38, 42, 45, 47, 48]. In total, 12,939 patients were included in the meta-analysis. A summary of the methodological quality of studies is displayed in Table 1.

Predictive accuracy of the ISAR for adverse outcomes at 30 days, 3 and 6 months

At 6 months, the sensitivity of an ISAR score of ≥2 for predicting ED return, emergency hospitalisation and mortality is 0.80 (95% CI 0.70–0.87), 0.82 (95% CI 0.74–0.88) and 0.87 (95% CI 0.75–0.94) respectively, with a specificity of 0.31 (95% CI 0.24–0.38), 0.32 (95% CI 0.24–0.41) and 0.35 (95% CI 0.26–0.44). There are inadequate data available to perform an analysis on functional decline. At 30 days, pooled estimates of sensitivity at a cut-point of ≥2 are 0.81 (95% CI 0.73–0.87) for ED return, 0.83 (95% CI 0.75–0.90) for hospitalisation, 0.91 (95% CI 0.80–0.96) for functional decline and 0.97 (95% CI 0.89–0.99) for mortality. The pooled sensitivity, specificity and the respective variance of the logit-transformed sensitivity and specificity for each outcome at 30 days, 3 and 6 months are presented in Table 2. These pooled estimates demonstrate that the ISAR has modest predictive accuracy as a screening tool, with a consistently high sensitivity (≥80% for all outcomes) and a moderate to low specificity across all outcomes and time points. Statistical heterogeneity across studies is low, reflected in the values for the variance of logit-transformed sensitivity and specificity (Table 2). Appendix 4 (Supplementary data, available in Age and Ageing online) illustrates the summary ROC curves for all outcomes across all time points. Summary estimates are broadly similar when we performed a sensitivity analysis excluding the studies with evidence of spectrum bias (see Supplementary data, Appendix 5, available in Age and

Ageing online).

Bayesian analysis

Using Bayes theorem, the pre-test and post-test probability of adverse outcomes at 30 days, 3 and 6 months is presented in Table 3. At 6 months, an ISAR score of <2 predicts a lower probability of ED return from 33% to 25%, emergency hospitalisation from 32% to 21% and mortality by almost two-thirds (from 11% to 4%). At 3 months, a score of <2 almost halves the probability of an ED return (from

30% to 16%) and mortality (from 7% to 3%). Consistent with modest values for sensitivity when compared with low values for specificity, the c statistic is

Table 1. Methodological quality of the studies included in the review

	Risk of bias			Applicability concerns			
	Patient selection	Index test	Reference standard	Flow and timing	Patient selection	Index test	Reference standard
Asomaning 2013	Unclear	Unclear	Unclear	Low	Low	Low	Low
Braes 2009	Low	Low	Unclear	Low	Low	Low	Low
Braes 2010	Low	Low	Unclear	Low	Low	Low	Low
Buurman 2011	Low	Low	Unclear	Low	Low	Low	Low
De Saint-Hubert 2010	Low	High	Unclear	Low	High	Low	Low
Dendukuri 2004	Low	Low	Unclear	Low	Unclear	Low	Low
Deschodt 2011	Low	Low	Unclear	Low	Low	Low	Low
Di Bari 2012	Low	Low	Unclear	Low	Low	Low	Low
Edmans 2013	Low	Low	Unclear	Low	Low	Low	Low
Geyskens 2008	Low	Low	Unclear	Low	Low	Low	Low
Graf 2012	High	Unclear	Unclear	Low	High	Low	Low
Heim 2015	Low	Low	Unclear	Low	High	Low	Low
Hoogerduijn 2010	Low	Low	Unclear	Low	Low	Low	Low
McCusker 1999	Low	Low	Unclear	Low	Low	Low	Low
McCusker, Bellavance 2000	Low	Low	Unclear	Low	Low	Low	Low
McCusker, Cardin 2000	Low	Low	Unclear	Low	Low	Low	Low
Moons 2007	Low	Low	Unclear	Low	Low	Low	Low
Rosted 2014	Unclear	Low	Low	Low	Low	Low	Low
Salvi 2009	Low	Low	Unclear	Low	Low	Low	Low
Salvi 2012	Low	Low	Unclear	Low	Low	Low	Low
Salvi, Morichi, Grilli 2012	Low	Low	Unclear	Low	Low	Low	Low
Singler 2014	Low	Low	Unclear	Unclear	Low	Low	Low
Sirois 2013	Low	Low	Unclear	Low	High	Low	Low
Suffoletto 2016	Low	Low	Low	Low	Low	Low	Low

Yim 2011	Unclear	Low	Unclear	Low	Unclear	Unclear	Low	

Table 2. Summary estimates of sensitivity and specificity for all studies

Outcome	Number of studies	Number of patients	Sensitivity	95% CI	Variance logit (sensitivity)	Specificity	95% CI	Variance logit (specificity)
Functional decline								
30 days	4	1,237	0.91	0.80–0.96	0.56	0.27	0.19–0.37	0.17
3 months	9	2,328	0.83	0.77–0.88	0.14	0.34	0.28–0.41	0.13
ED return								
30 days	10	4,328	0.81	0.73–0.87	0.40	0.29	0.22–0.38	0.35
3 months	5	1,090	0.84	0.73–0.91	0.39	0.38	0.29–0.48	0.17
6 months	5	4,485	0.80	0.70–0.87	0.36	0.31	0.24–0.38	0.14
Hospitalisation								
30 days	9	2,716	0.83	0.75–0.90	0.52	0.26	0.19–0.34	0.32
3 months	6	1,814	0.80	0.70–0.87	0.33	0.38	0.30–0.46	0.14
6 months	5	4,484	0.82	0.74–0.88	0.27	0.32	0.24–0.41	0.17
Mortality								
30 days	6	2,152	0.97	0.89–0.99	0.58	0.24	0.16–0.34	0.41
3 months	6	2,338	0.85	0.72–0.92	0.55	0.37	0.29–0.45	0.15
6 months	5	5,808	0.87	0.75–0.94	0.76	0.35	0.26–0.44	0.19

Table 3. Bayesian analysis for all studies

Outcome	Pre-test probability	Positive LR	Post-test probability	Negative LR	Post-test probability	c statistic
	% (95% CI)	(95% CI)	% Positive LR	(95% CI)	% Negative LR	(95% CI)
Functional decline						
30 days	36.9 (34.3–39.7)	1.34 (1.09–1.40)	43.9 (36.3–48.0)	0.35	(0.16–0.77)	17.0 (7.7–33.6) 0.55 (0.51–0.59)
3 months						

ED return 24.4 (22.7–26.2) 1.26 (1.15–1.39) 28.9 (25.2–33.0) 0.49 (0.37–0.67) 13.7 (9.8–19.2) 0.65 (0.61–0.69)

30 days 17.2 (16.1–18.3) 1.15 (1.06–1.24) 19.3 (16.9–21.7) 0.65 (0.50–0.84) 11.9 (8.8–15.8) 0.58 (0.54–0.62)

3 months 30.0 (27.4–32.8) 1.35 (1.23–1.49) 36.7 (31.7–42.1) 0.43 (0.30–0.62) 15.6 (10.2–23.2) 0.62 (0.57–0.66)

6 months

Hospitalisation 33.3 (31.9–34.7) 1.15 (1.12–1.20) 36.5 (34.4–38.9) 0.65 (0.51–0.82) 24.5 (19.3–30.3) 0.51 (0.46–0.55)

30 days 18.4 (17.0–19.9) 1.13 (1.06–1.20) 20.3 (17.8–23.0) 0.63 (0.48–0.84) 12.4 (9.0–17.3) 0.54 (0.50–0.58)

3 months 27.8 (25.8–29.9) 1.28 (1.16–1.42) 33.0 (28.7–37.7) 0.53 (0.38–0.75) 16.9 (11.7–24.2) 0.58 (0.54–0.62)

6 months

Mortality 32.2 (30.9–33.6) 1.20 (1.11–1.30) 36.3 (33.2–39.7) 0.57 (0.44–0.74) 21.3 (16.4–27.4) 0.58 (0.54–0.62)

30 days 6.1 (5.2–7.2) 1.29 (1.12–1.48) 7.7 (5.8–10.3) 0.12 (0.02–0.57) 0.8 (0.1–4.2) 0.80 (0.76–0.83)

3 months 7.1 (6.1–8.2) 1.34 (1.23–1.45) 9.3 (7.4–11.5) 0.42 (0.25–0.71) 3.1 (1.6–6.0) 0.57 (0.53–0.62)

6 months 11.0 (10.2–11.8) 1.34 (1.24–1.44) 14.2 (12.3–16.2) 0.37 (0.22–0.62) 4.4 (2.4–7.7) 0.57 (0.53–0.61)

consistently low, falling below the threshold for moderate discrimination (c statistic 0.7–0.9), except in the case of mortality at 30 days.

Impact analysis of the ISAR tool in a clinical setting

Three studies examined the impact of the ISAR rule on process of care and patient outcomes [49–51]. Appendix 6 (Supplementary data, available in Age and Ageing online) contains the descriptive characteristics of these studies. In 2001, McCusker et al. conducted a quasi-randomised controlled trial (RCT) where patients ≥65 years who screened ISAR positive (≥2) were randomly assigned to either usual care (n = 178) or a brief intervention (n = 210). The intervention consisted of standardised nursing assessment in the ED and preparation of a discharge plan that attempted to optimise the use of appropriate multidisciplinary outpatient and community services [51]. The intervention was associated with a significantly reduced rate of functional decline or death at 4 months (odds ratio (OR) = 0.53, 95% CI = 0.31–0.91). There were no significant effects on depressive symptoms or caregiver physical or mental health scores. Edmans et al. [49] conducted an RCT including 433 patients aged ≥70 years screened as high risk (score ≥2) by the ISAR who were discharged within 72 h of attending an acute medical assessment unit (AMU). The intervention consisted of an initial assessment by a

geriatrician in the AMU and further outpatient management by geriatricians, including advice and increased support to primary care services. Follow-up at 90 days demonstrated no significant differences between groups regarding the length of time to readmission or use of secondary or long-term care services [49]. Finally, Warburton et al. [50] conducted a controlled before–after study in 277 patients aged ≥75 years. Thirty-eight patients screened as high risk by ISAR were referred for a specific 'Elder Alert' intervention that incorporated a care plan for appropriate intervention and targeted, coordinated, preventive, community-based services. Outcomes at 30 days indicate signficantly lower emergency hospital admission rates in the intervention group when compared with the ISAR high-risk group who did not receive the intervention ($P < 0.05$). The methodological quality of these studies in described in Appendix 7 (Supplementary data, available in Age and Ageing online).

Discussion

Statement of principal findings

This systematic review and meta-analysis demonstrates that the ISAR has modest predictive accuracy as a screening tool in the ED, with high pooled estimates of sensitivity (≥80% for all outcomes) across all time points. An ISAR score of <2 predicts a lower probability of ED return, emergency hospitalisation within 6 months following ED visit. Three impact analysis studies were identified where the ISAR was used to screen high-risk older adults for targeted geriatric interventions. Findings across patient and process outcomes were varied between the studies, indicating the need for further evaluation of the ISAR rule and subsequent targeted interventions in clinical practice.

Results in the context of previous studies

Research indicates that the ISAR tool is the most commonly used screening tools to identify older adults at risk of functional decline in the ED [52, 53]. Our findings are at odds with a recent systematic review by Carpenter et al. [54] that analysed the predictive value of tools for predicting ED return, hospital readmission and functional decline in older adults following ED discharge. Three screening instruments were examined in the meta-analysis including the ISAR, the Triage Risk Screening Tool and Variables Indicative of Placement Risk. Findings indicated that none of the tools significantly increased or decreased the risk of subsequent adverse outcomes [54]. The contrast between our findings and those in this earlier review may be explained by the differing methods used to identify and pool studies. We identified and included data from 32 studies in our review, versus 18 studies in the former review [54]. Moreover, we used individual patient data rather than aggregate data to calculate summary estimates of sensitivity and specificity, allowing for a more accurate data analysis by accounting for heterogeneity between studies and influences of sample size.

Two recent reviews of other models to predict hospital admission from the community [55] and readmission [56] reported poor performance of included models overall. By comparison, we found that the ISAR performs reasonably well, as usually sensitivity for any model predicting an outcome as unpredictable as return ED visit and/or emergency admission is quite low. However, care is needed when applying such measures in clinical practice as the ISAR tool contains questions that may be affected by the older adults' current health status and state of distress, such as cognition and ability to manage activities of daily living.

Three impact analysis studies were included where the ISAR was used to screen high-risk older adults for targeted geriatric interventions. All interventions comprised comprehensive geriatric assessment (CGA) and findings across patient and process outcomes varied across studies. A systematic review of five RCTs examined the impact of CGA interventions on outcomes in frail older adults discharged from acute hospital within 72 h following index ED visit [57] and found no clear evidence in support of CGA

interventions in terms of mortality [risk ratio (RR) 0.92 (95% CI 0.55–1.52)], readmissions [RR 0.95 (95% CI 0.83–1.08)] or for subsequent institutionalisation, functional status, quality of life or cognition [57]. Another approach that has been explored is the roll out of intensive case-based management community interventions in those deemed at high risk of adverse outcomes. However, a recent systematic review and meta-analysis of 36 studies of community-initiated case management for adults with chronic medical conditions concluded that this intervention is not effective in reducing either primary or secondary care healthcare utilisation [58].

Strengths and weaknesses

Data were pooled from 32 studies in 12 different countries across four continents, enhancing the generalizability of the findings. We used individual patient data rather than aggregate data to calculate summary estimates of sensitivity and specificity. This allowed for more accurate data analysis by accounting for heterogeneity between studies and the influences of sample size. However, we were unable to explore the predictive accuracy of different cut-points of the ISAR as we did not have access to individual patient ISAR scores that mapped to the occurrence/non-occurrence of subsequent adverse outcomes. In addition, the ISAR was derived to screen all ED patients either hospitalised or discharged after an ED visit and for the purpose of completeness we included studies examining both populations either individually or as a composite group in our review. However, not enough data were available in the studies to perform a separate analysis on discharged and hospitalised patients as individual cohorts. Furthermore, the majority of studies only enrolled patients on weekdays during daytime hours and 10 of the 32 studies included older adults' with age categories other than those ≥65 years, including cut-offs of ≥75 years (n = 7), ≥70 years (n = 2) and ≥60 years (n = 1), which may have resulted in selection bias. However, it was not possible to complete a separate analysis on these studies.

Clinical implications and areas for further research

This review demonstrates that the incidence of ED return among older adults in the first 6 months following index visit is high at 33%. Given the complex needs and clinical presentations of these patients combined with time pressures and the need to maintain rapid patient turnover, optimal assessment and discharge planning for older adults in ED and hospital settings is a complex and challenging process. Screening tools capable of identifying patients at high risk of adverse events have the potential to improve patient care by assisting clinicians in the management of these patients. Our findings that an ISAR score of <2 indicates a lower probability of ED return, emergency hospitalisation within 6 months following ED visit suggests that the ISAR may be considered to be a useful screening tool in clinical practice. It also has the advantage of being easy to administer and score which adds to its clinical utility in the busy ED setting. However, modifications to the six component questions in the ISAR should also be explored. For example, one question included in the ISAR tool is the use of ≥3 medications which is not the typical definition of polypharmacy in current clinical practice. Salvi et al. [9] reported that 77% of their population were taking ≥3 medications. In terms of improving the sensitivity of the tool, modifications to this question such as use of ≥5 medications may be more appropriate in clinical reality. In addition, the weighted contribution of the six questions warrants further investigation through the exploration of the estimated multivariable regression coefficients.

Given the complexity of the clinical issues related to the care of vulnerable older people, all screening tools need to be used as an adjunct to clinical decision-making [21]. Identification of high-risk older people is a first step but needs to be supplemented by interventions that are effective in reducing adverse outcomes for these patients. To date, there is limited evidence for any single approach in achieving this aim but research is ongoing and based on the current literature multifaceted

interventions designed taking the contextual factors of the local healthcare system into account are most likely to be successful [55, 56].

Conclusion

The ISAR has modest predictive accuracy as a screening tool in the ED, with consistently high pooled sensitivity estimates across all outcomes and time points. It may serve as a useful adjunct in clinical decision-making when determining which older adults can be safely discharged from the ED.

Key points

- Older adults are the most frequent users of emergency services and have higher rates of adverse outcomes following ED visit.
- The ISAR has modest predictive accuracy as a screening tool for adverse outcomes within 6 months following ED visit.
- An ISAR score of <2 predicts a lower probability of ED return, emergency hospitalisation and mortality within 6 months.
- The ISAR may be useful as an adjunct to clinical decisionmaking when determining which older adults can be safely discharged.

Supplementary data

Supplementary data mentioned in the text are available to subscribers in Age and Ageing online

Acknowledgements

We would like to gratefully acknowledge the data contributed by the following authors: Katrin Singler, Jane McCusker, Marie de Saint-Hubert, Bianca Buurman, Mieke Deschodt,

Veronica WT Yim, Allen Huang, Milena Bolaños Sanchez, Jita Hoogerduijn, Noor Heim, Brian Suffoletto and Marcel Émond; and the information provided by Elisabeth Rosted, Christophe Graf and Philip Moons.

Conflicts of interest None declared.

Funding This work was supported by the Health Research Board (HRB) of Ireland through the HRB Centre for Primary Care Research under Grant HRC/2007/1.

References

1. Samaras N, Chevalley T, Samaras D et al. Older patients in the emergency department: a review. Ann Emerg Med 2010; 56: 261–69.

2. Graf CE, Zekry D, Giannelli S, Michel JP, Chevalley T. Efficiency and applicability of comprehensive geriatric assessment in the emergency department: a systematic review. Aging Clin Exp Res 2011; 23: 244–54.

3. Ellis G, Marshall T, Ritchie C. Comprehensive geriatric assessment in the emergency department. Clin Interv Aging

2014; 9: 2033–43.

4. Foo CL, Siu VW, Ang H et al. Risk stratification and rapid geriatric screening in an emergency department – a quasirandomised controlled trial. BMC Geriatr 2014; 14: 98.

5. McCusker J, Verdon J. Do geriatric interventions reduce emergency department visits? A systematic review. J Gerontol A Biol Sci Med Sci 2006; 61: 53–62.

6. McGinn TG, Guyatt GH, Wyer PC et al. Users' guides to the medical literature: XXII: how to use articles about clinical decision rules. Evidence-Based Medicine Working Group. JAMA 2000; 284(1):79–84.

7. McCusker J, Bellavance F, Cardin S et al. Detection of older people at increased risk of adverse health outcomes after an emergency visit: the ISAR screening tool. J Am Geriatr Soc 1999; 47: 1229–37.

8. Singler K, Heppner HJ, Skutetzky A et al. Predictive validity of the identification of seniors at risk screening tool in a german emergency department setting. Gerontology 2014; 60: 413–19.

9. Salvi F, Morichi V, Grilli A et al. Predictive validity of the Identification of Seniors At Risk (ISAR) screening tool in elderly patients presenting to two Italian Emergency Departments. Aging Clin Exp Res 2009; 21: 69–75.

10. Macaskill P, Gatsonis C, Deeks J et al. Cochrane Handbook for Systematic Reviews of Diagnostic Test Accuracy 2010. The Cochrane Collaboration (online). Available at: http:// dta.cochrane.org/handbook-dta-reviews. (accessed 15 May 2015).

11. Moher D, Liberati A, Tetzlaff J et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. BMJ 2009; 339: b2535.

12. Whiting PF, Rutjes AW, Westwood ME et al. QUADAS-2: a revised tool for the quality assessment of diagnostic accuracy studies. Ann Intern Med 2011; 155: 529–36.

13. Higgins JP, Altman DG, Gotzsche PC et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. BMJ 2011; 343: d5928.

14. EPOC. Effective Practice and Organisation of Care. Norwegian Knowledge Centre for the Health Services 2014. Available at:

http://epoc.cochrane.org/ (20 June 2015, date last accessed).

15. Billington J, Fahey T, Galvin R. Diagnostic accuracy of the STRATIFY clinical prediction rule for falls: a systematic review and meta-analysis. BMC Fam Pract 2012; 13: 76.

16. Cousins G, Bennett Z, Dillon G, Smith SM, Galvin R. Adverse outcomes in older adults attending emergency department: systematic review and meta-analysis of the Triage Risk Stratification Tool. Eur J Emerg Med 2013; 20: 230–9.

17. Barry E, Galvin R, Keogh C, Horgan F, Fahey T. Is the Timed Up and Go test a useful predictor of risk of falls in community dwelling older adults: a systematic review and meta- analysis. BMC Geriatr 2014; 14: 14.

18. Deeks JJ, Altman DG. Diagnostic tests 4: likelihood ratios. BMJ 2004; 329: 168–9.

19. Swets JA. Measuring the accuracy of diagnostic systems. Science 1988; 240: 1285–93.

52. Sutton M, Grimmer-Somers K, Jeffries L. Screening tools to identify hospitalised elderly patients at risk of functional decline: a systematic review. Int J Clin Pract 2008; 62: 1900–9.

53. Beaton K, Grimmer K. Tools that assess functional decline: systematic literature review update. Clin Interv Aging 2013; 8: 485–94.

54. Carpenter CR, Shelton E, Fowler S et al. Risk factors and screening instruments to predict adverse outcomes for undifferentiated older emergency department patients: a systematic review and meta-analysis. Acad Emerg Med 2015; 22: 1–21.

55. Wallace E, Stuart E, Vaughan N et al. Risk prediction models to predict emergency hospital admission in communitydwelling adults: a systematic review. Med Care 2014; 52: 751–65.

56. Kansagara D, Englander H, Salanitro A et al. Risk prediction models for hospital readmission: a systematic review. JAMA 2011; 306: 1688–98.

57. Conroy SP, Stevens T, Parker SG et al. A systematic review of comprehensive geriatric assessment to improve outcomes for frail older people being rapidly discharged from acute hospital: 'interface geriatrics'. Age Ageing 2011; 40: 436–43.

58. Stokes J, Panagioti M, Alam R et al. Effectiveness of case management for 'at risk' patients in primary care: a systematic review and meta-analysis. PLoS One 2015; 10: e0132340.